DISTRIBUTION OF NUTRIENT SALTS IN LAKE MANZALAH (EGYPT)

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Abstract: The spatial and monthly distribution of PO_4-P, NO_3-N, NO_2-N NH_3-N and SiO_2-Si in the surface water of lake Manzalah (EGYPT) was studied during the period from January to June 1982. Results are discussed in relation to the allochthonous supply of the nutrients from the brackish water drains discharging into the lake.

INTRODUCTION

Lake Manzalah, the largest northern delta lake in Egypt (surface area about 1200 km^2) occupies the north eastern area between Damietta branch of the Nile and Suez Canal (Fig. 1). The lake is shallow, average depth about 1.25 m and is traversed by several sandy and clayey islets which divide the lake into several more or less isolated small basins known locally as 'Bohour'. The northern part of the lake is affected by marine water invasion through El Gamil outlet and Damietta estuary, while the southern and south western parts recieves annually 6650×10^6 m^3 of brackish and freshwater from several drains and canals (Fig. 1).

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MATERIAL AND METHODS

In this treatment the lake is subdivided into two distinct regions i.e. the north western region and the lake proper. The former region is now almost separated from the main lake by a continuous land barrier with few culverts which allow for limited exchange of water on both sides. The lake proper which comprises the greater part of the lake is in turn subdivided into 5 zones shown in Figure 1. Each of these zones is affected to variable degrees by fresh, brackish and marine water discharge. These zones are physiographically identified by the presence of more or less continuous raws of islets.

Throughout the period from January to June 1982, spectrophotometric determination of PO_4-P, NO_3-N, NO_2-N, NH_3-N and SiO_2-Si were made[1] on monthly surface samples collected from about 50 stations distributed in the various zones of the lake as well as from the mouths of the drains. The results are shown in Tables (1-4).

DISCUSSION

The North Western Region: The high salinity of the north western region particularly in January and February (Table 1) clearly demonstrates that the marine water entering this region (salinity 37 ‰ - 38 ‰) is significantly concentrated by evaporation and dissolution of salts from the bottom through long periods of storage in this shallow basin. The high values of nutrient salts recorded in this region, particularly in February (Table 1), are most probably due to active processes of remineralization and regeneration from bottom deposits.

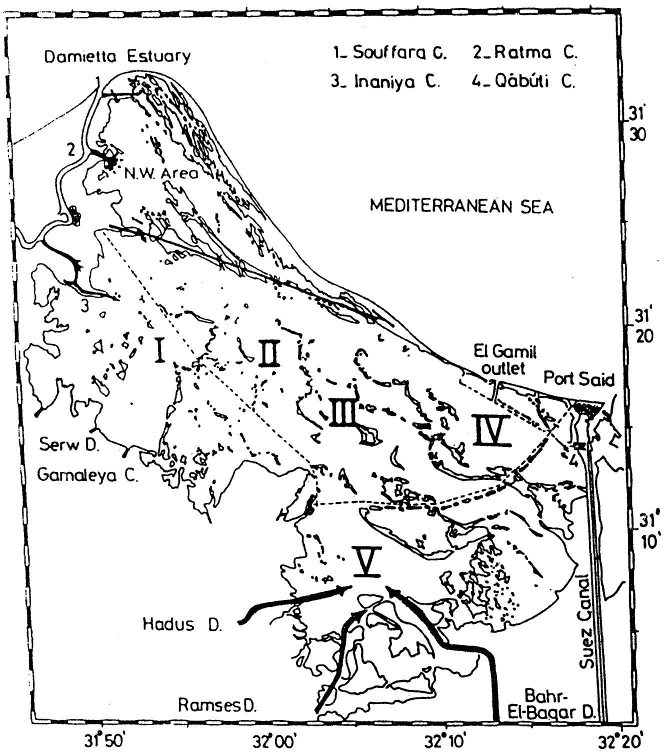

Fig. 1- Map of lake Manzalah.

The decrease in average salinity observed during spring months was paralleled by a remarkable decrease in most nutrients.

Table 1. Monthly averages of salinity and dissolved inorganic nutrients in µg at/l in the northwestern region of lake Manzalah during the period of study.

	Jan.	Feb.	March	April	May	June
S ‰	45.15	43.26	37.56	35.43	32.40	38.57
PO_4-P	3.62	5.83	2.36	0.13	0.22	0.17
NO_3-N	3.92	0.66	13.54	2.04	0.08	0.00
NO_2-N	0.03	0.59	0.38	1.28	0.30	0.04
NH_3-N	0.18	3.65	1.19	3.03	1.81	2.12
SiO_2-Si	8.92	55.59	42.28	19.27	4.12	34.86

Furthermore, the concentration of nutrients in this region was, on the whole, slightly lower than the corresponding values of zone I. This may indicate that the decrease of salinity and nutrients in this region during spring months is most probably due to the dilution caused by the northward flow of brackish water from the lake proper.

Lake Proper: Table 2 summarises the monthly average values of the parameters studied in this region. The average salinity of the lake proper amounted to 2.20 ‰. The distribution of salinity in different zones clearly reflects the effect of brackish water discharge and marine water invasion. The highest average (3.15‰) was recorded in zone IV probably reflecting the effect of marine water invasion through El-Gamil outlet on this zone. This effect, however, was mostly localized to a few kilometers near the outlet. On the other hand, the lowest average (1.60‰) occured in zones I and V which are affected with fresh and brackish water discharge. The monthly average variations in salinity in all zones (Table 2) clearly reflects the corresponding variations in the total brackish water discharge.

Table 2. Monthly averages of salinity and dissolved inorganic nutrients in µg at/l and the total amount of brackish water discharge in the lake proper during the period of study.

	Jan.	Feb.	March	April	May	June
Total discharge x 10^6 m^3	443.40	424.78	506.28	492.43	516.35	563.37
S ‰	2.32	2.43	2.24	2.01	1.97	2.24
PO_4-P	6.24	4.78	4.86	1.58	2.68	1.16
NO_3-N	5.06	2.24	9.98	3.84	3.59	3.30
NO_2-N	0.44	0.63	1.05	2.39	1.21	0.99
NH_3-N	0.55	5.68	2.39	4.94	3.72	5.69
SiO_2-Si	36.71	49.30	54.94	58.11	96.25	85.30

The nutrient budget of the lake proper is mostly dependent upon the large amounts of nutrients transported to the lake through the main drains. The contribution of each drain to the nutrient budget of the lake depends upon the amount of discharge and the concentration of each of the nutrient salts. As shown in Table 3, Hadus and Bahr El-Baqar drains contribute the major part of nutrient input to the lake. The highest amount of phosphate was brought by Bahr El-Baqar drain. The water of this drain is heavily polluted, with large amounts of suspended solids (maximum 145.6 mg/l) and completly anoxic. The concentration of hydrogen sulphide varied between 8.46 and 17.76 ml/l. Adsorption of large amounts of phosphate phosphorus on suspended matter is not to be expected in such conditions consequently most of the available inorganic phosphorus is released in the dissolved form. This may explain the high concentration of dissolved inorganic phosphorus recorded in this environment (maximum 23.92 µg at/l). It is interesting to note that significantly low values of phosphate (0.1 to 4.10 µg at/l) were recorded at stations still affected by the northward flow of this drain water. The oxygen content at these stations was relatively high (4.60 to 10.20 ml/l). The amount of suspended solids were still high (84.4 mg/l). The adsorption of large amounts of phosphates on the suspended particles in such oxic conditions may explain the low phosphate values recorded at these stations. On the other hand, the anoxic character of Bahr El-Baqar drain water explains the high concentration of ammonia (average 14.70 µg at/l) and the low nitrate values recorded at the mouth of this drain (average 0.80 µg at/l). Although the amount of water conveyed by Hadus drain was almost twice that of Bahr El-Baqar drain, its contribution to the budget of dissolved inorganic phosphate is much lower (Table 3).

The water of this drain is always oxygenated with relatively high load of suspended solids. It seems therefore that considerably large amounts of phosphate are adsorbed on the silt and suspended solids in this drain water. Most of these suspended solids are deposited in the northern part of zone V. On the other hand, the largest input of nitrate (92.50 %) and nitrite (81.05 %) is transported into the lake through Hadus drain.

Table 3. Average dissolved inorganic nutrient salts (metric tons/ month) discharged into the lake by the main drains during the period of study.

	Average discharge x 10^6 m^3	PO_4-P	NO_3-N	NO_2-N	NH_3-N	SiO_2-Si
Hadus	231.72	25.10	61.95	11.90	14.05	929.21
B. Baqar	128.06	73.76	1.42	2.19	26.49	520.00
Ramses	19.28	1.06	2.85	0.53	1.11	66.12
Inaniya	13.43	1.87	0.93	0.07	0.70	23.35

The silicate content of the drain water was always high. The average silicate content of Inaniya water was remarkably lower (average 65.68 µg at/l) than that of Hadus drain (average 132.23 µg at/l) and Bahr El-Baqar drain (138.90 µg at/l). On the whole, the silicate input to the lake supplied by these drains is more or less proportional to the amount of water discharged by each drain (Table 3).

The zonal concentration of the different nutrient salts is directly correlated with the amount of fresh or brackish water discharged through the drains. In other words, the highest concentrations were recorded in zone V and the lowest levels occured in zone I (Table 4).

Table 4. Average salinity and concentration of dissolved inorganic nutrients in the different zones of the lake proper during the period of study.

	S ‰	PO_4-P	NO_3-N	NO_2-N	NH_3-N	SiO_2-Si
I	1.60	2.84	3.52	0.19	2.12	54.46
II	2.47	2.41	2.95	0.44	2.78	52.76
III	2.22	3.49	7.88	0.84	2.89	72.96
IV	3.15	3.17	2.26	0.70	3.95	65.55
V	1.56	5.84	6.73	3.42	7.41	71.44

The average zonal concentrations of nutrients in other zones is probably controlled by dynamical conditions between the autochthonous regeneration of nutrients from bottom deposits and the allochthonous supply by drain waters. The prevailing level of nutrients is dependent on the rate of increase brought up by both processes and that of consumption by aquatic plants. It is worth to mention that the spatial and monthly variations in the concentrations of almost all nutrients varied widely in different stations. Such variations were mostly recorded in small isolated shallow areas particularly scattered in the central part of the lake. These areas are densily populated by plant vegetation and forms special biotopes with ecological characteristics different from the surrounding water.

REFERENCE

1. Strickland J.D.H. and Parsons T.R., 1972: A Practical Hand-book of Sea Water Analysis. Fish. Res. Bd. Canada, No. 125 (2nd edition).